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REPORT NO. FTDM2812
DATE: 2 July 1962

HYDRAULIC SYSTEM - AXIAL PISTON PUMP,
PARTIAL EVALUATION TEST

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GENERAL DYNAMICS | FORT WORTH

Department 6
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CONVAIR
FORT WORTH

TEST DATA MEMORANDUM

FTDM NO. 2812
MODEL B-58
TEST NO. F-8284 and 50-1106

TEST: HYDRAULIC SYSTEM - ROYAL LUBRICANT FLUID, PARTIAL EVALUATION TEST

OBJECT: To determine if Royal Lubricant fluid, Royco 846, is a suitable alternate to Oronite 8515 in the B-58 hydraulic system.

TEST SPECIMENS:

	Supplier
Royco 846 (MIL-H-8446B Hydraulic Fluid) (No identifying lot or batch number)	Royal Lubricant Company Hanover, New Jersey
Oronite 8515 (MIL-H-8446B Hydraulic Fluid)	Oronite Chemical Company San Francisco, California

PROCEDURE AND RESULTS: See Tables I and II

DISCUSSION: Royal Lubricant Company's hydraulic fluid, Royco 846, has been approved by WADD to meet specification MIL-H-8446B (Hydraulic Fluid, Non Petroleum Base, Aircraft) and has been placed on the QPL. Although Oronite 8515 is the only MIL-H-8446 fluid being used in the B-58, partial or complete substitution by the Royal fluid would result in considerable savings. The purpose of this test, therefore was to compare some critical properties of Royco 846 with those of Oronite 8515 and with applicable specification requirements in an effort to determine the suitability of the Royal fluid for use in the B-58 airplane.

Tables I and II show the tests performed, the procedures, and the results obtained. The mixed fluids sample (100 ml Royco + 200 ml Oronite) was included in the test to investigate properties of the mixture and mutual compatibility of the fluids. Results indicate that the fluids compare favorably and pass specification requirements for all properties tested with the exception of compatibility with Q2825 O-rings.* As may be noted in Table II, this batch of Royco 846 had a more deleterious effect on the properties of Q2825 O-rings than did Oronite 8515 - all O-ring properties tested being degraded after immersion in Royco 846.

CONCLUSIONS: A comparison was made of pertinent properties of Royco 846 and Oronite 8515 hydraulic fluids. This batch of Royco 846 degraded B-58 hydraulic system O-rings to a greater extent than did Oronite 8515.

The tests described in this report were conducted between 12-1-60 and 2-9-61.

*Identical to MS 26775 except for compound; compound is Plastics and Rubber Products Co. No. 3046-60.

WITNESS:

BY H J Weltman

CHECKED H H Hoffman

APPROVED K E Duncan

DATE: 20 Ma[illegible] 961

TABLE I

COMPARISON OF PROPERTIES OF ROYCO 846 AND ORONITE 8515 HYDRAULIC FLUIDS

Test:	Procedure	Royco 846	Oronite 8515	Royco & Oronite 100/200 ml.mix	Requirements
Flash point, °F	ASTM D-92	400	395	not determined	395 minimum
Viscosity @ -65°F, cs	ASTM D-445	2204	2394	not determined	2500 maximum
@ 100°F, cs		22.97	24.17	not determined	no requirement
@ 210°F, cs		7.84	8.16	7.87	no requirement
@ 400°F, cs		2.73	2.78	not determined	2.5 minimum
Neutralization Number	ASTM D-664	0.06	0.01	0.04	0.2 maximum
Specific HT, BTU/lb - °F	Adiabatic Calorimeter (see WADC Tech. Report 54-601)				
@ 100°F		0.47	0.48	not determined	no requirement
@ 200°F		0.49	0.51	not determined	no requirement
@ 300°F		0.57	0.57	not determined	no requirement
Density, gm/cc	ASTM D-1217				
@ 0°F		.9592	.9561	not determined	no requirement
@ 100°F		.9185	.9142	not determined	no requirement
@ 210°F		.8735	.8679	not determined	no requirement
Low Temperature Stability	MIL-H-8446B Paragraph 4.5.4 (except test time = 10 hours	Passes	Passes	Passes	no gel, crystallization or solidification
Vapor Pressure @ 400°F, mm Hg.	MIL-H-8446B Paragrapn 4.5.7 (Isoteniscope)	1.15	1.08	not determined	5.0 mm Hg. maximum
Evaporation (6.5 hours, @ 400°F)	ASTM D-972				
% Loss		33.7	30.1	not determined	no requirements
Viscosity, of residue @ 100°, cs		43.23	48.70	not determined	no requirements
Viscosity, of residue @ 210°, cs		14.14	15.50	not determined	no requirements
Slide Evaporation Test	FTMS 791-353T				
6-1/2 hours @ 400°F		Resinous film	Resinous film	not determined	no requirement
4 hours @ 400°F				Resinous film	no requirement
Water content, %	FTMS 791-3253	0.0057	0.0078	not determined	0.01 % maximum
Oxidation and Corrosion Stability	MIL-H-8446B Paragrapn 4.5.1				
Neutralization number increase		0.87	0.98	0.90	1.0 maximum
Viscosity change, %		-4.2	-9.8	-9.5	±35.0
Metal coupon weight change, mg/sq. cm.					
Copper		+0.03	+0.10	+0.09	± 0.4
Steel		-0.05	+0.02	-0.02	± 0.2
Silver		-0.05	-0.02	-0.07	± 0.2
Aluminum		-0.02	-0.04	-0.03	± 0.2
Appearance of metals		all pass	all pass	all pass	no pitting, etching, or corrosion

TABLE I
(continued)

COMPARISON OF PROPERTIES OF ROYCO 846 AND ORONITE 8515 HYDRAULIC FLUIDS

Test:	Procedure	Royco 846	Oronite 8515	Royco & Oronite 100/200 ml.mix	Requirements
O-Ring Compatibility*	FMS 0018D Par. 3**				
Volumetric swell, %		14.9	12.2	12.1	
TR-10-Initial, °F		-51°	-51°	-51°	
TR-10-After Soak, °F		-58°	-61°	-58°	SEE TABLE II
Tensile Strength - - initial, psi		1735	1735	1735	
Tensile Strength - - after soak, psi		590	805	800	
Compatibility with primer	FMS 0003A Par.3.7.7.**				
Effect on hardness		passes	passes	passes	Shall not lower original hardness or impact resistance.
Effect on impact		passes	passes	passes	
Compatibility with enamel	FMS 0004A Par. 3.7.7.**				
Effect on hardness		passes	passes	passes	Shall not lower original hardness or impact resistance.
Effect on impact		passes	passes	passes	
Compatibility with FZC-4-035 - Wire Insulation	FZC-4-035**				
Dielectric breakdown		none	none	none	No dielectric breakdown
Compatibility with EC 1300 adhesive	Cylinder adhesion specimens*** were prepared with a 14 day room temperature cure. The specimens were then immersed in the test fluids for 5 hrs. at 220°F. Adhesion tests were made on a Baldwin Test Machine at room temperature using a load rate of 2500 lbs./minute.				
Initial adhesion of specimen, psi (av.of 3).		303 (40% coh.fail)	303 (40% coh.fail.)	303 (40% coh.fail.)	Comparison only - no requirements established.
Adhesion after fluid soak, psi (av. of 3).		133 (80% coh.fail.)	85 (67% coh.fail.)	113 (70% coh.fail.)	

* These results are the averages of replicate specimens in the test fluids.

For individual results, see Table II.

** See Supplemental Pages S-1 through S-6 for Details of Test Procedures.

*** See Supplemental Pages S-7 through S-9 for Test Specimen Details.

TABLE II

EFFECT OF HYDRAULIC FLUIDS ON Q 2825 O-RINGS (TESTS AS PER FMS0018D PARAGRAPH 3)

Specimens		Volumetric Swell, %	Tensile Strength, psi	Ultimate Elongation, %	Modulus at 100% Elongation, psi	TR-10, °F
O-rings soaked in Royco 846	(1)	15.3*	595*	112*	525*	(7) -58*
	(2)	15.9*	595*	103*	580*	(8) -58*
	(3)	16.0*	385*	74*	- *	(9) -58*
	(4)	13.9	555	140	525*	(10) Broke on elongation*
	(5)	14.3*	370*	70*	- *	
	(6)	14.2	730	124*	540*	
	Average	14.9	590	104	545	
O-rings soaked in Oronite 3515	(1)	11.2	770	146	440	(7) -61
	(2)	11.4	1115	175	495	(8) Broke on elongation*
	(3)	11.9	1145	169	495	(9) Broke on elongation*
	(4)	13.3	550*	108*	495	(10) Broke on elongation*
	(5)	12.7	605*	112*	495	
	(6)	12.6	820*	116*	525*	
	Average	12.2	705	138	490	
O-rings soaked in Royco [illegible] Oronite mix - [illegible] ml 200 ml)	(1)	11.-	[illegible]	146	495	(7) -59
	(2)	11.-	[illegible]	145	540*	(8) -61
	(3)	11.7	830	141	485	(9) -55
	(4)	12.-	550*	107*	525*	(10) Broke on elongation*
	(5)	12.3	1155	179	470	
	(6)	12.7	420*	87*	- *	
	Average	12.1	800	135	505	
O-rings as received (Oronite)	(1)	-	1765	294	415	(7) -51
	(2)	-	1830	302	385	(8) -51
	(3)	-	1830	292	325	(9) -51
	(4)	-	1545*	351	415	(10) -50
	(5)	-	1805	289	440	
	(6)	-	1750	281	430	
	Average		1735	285	400	
Requirements		6-14.5	1500 min. initial	250 min. initial	405 max. initial	-50 max. initial
			700 min. after soak	135 min. after soak	510 max. after soak	-59 max. after soak

* Denotes failure to meet specification.

Reference Page 3 Table I of FTDM 2812.

A. Extract of Applicable Paragraphs of FMS-0003A, Primer Epoxy Base.

Para. 3.7.7 Fluid Resistance.

Three Type B panels* shall be immersed, one each in the three test fluids specified in Paragraph 2.4.8. (Note. Type B panel = 6" x 3" .032" thick - unclad 7075T6 aluminum alloy QQ-A-283, given a chemical treatment conforming to Specification MIL-C-5541, and then sprayed with the primer to a coat thickness of 0.35 plus or minus 0.05 mil.) After 720 hours, the panels shall be removed from their respective fluids, and shall meet the requirements of Para. 2.4.8.

Para. 2.4.8 Fluid Resistance:

The primer shall be capable of withstanding immersion for 720 hours at room temperature in each of the test fluids listed below without dissolving, wrinkling, fading, and without loss of adhesion. The primer coat shall not show a decrease in hardness or impact from that specified in Para. 2.4.13 and 2.4.12.

a) Test Fluid - MIL-H-3136, Type III

b) Hydraulic Fluid - FMS-0006 (Same as MIL-H-8446B)

c) Lubricating Oil - MIL-L-7808

(Note: This test used only two test fluids, Oronite 8515 and Royco 846, in lieu of test fluids noted.)

Paragraph 3.7.13 Hardness:

A type B panel shall be used. Pencils ranging in hardness from H to 9H shall be prepared by cutting the wood to an angle of 45° to the lead, leaving 0.11 plus a minus 0.02 inch of lead exposed. The pencil lead shall then be squared by holding the lead vertically to a piece of fine sandpaper on a flat surface and grinding it with smooth, straight strokes, rotating the pencil 1/4 turn per stroke.

The pencil shall be held against the primer coat at an angle of 45° degrees, then pushed firmly downward and forward attempting to rupture the coat with a force just short of breaking the pencil lead. Any rupture of the primer coat shall be noted.

* Test panels were conditioned only per foot note of Para. 3.7.12.

on Supplement Page S-2.

The test shall be repeated for each pencil hardness to determine the correlation with the Coleman-Smith hardness scale of Table IV.

The primer coat shall meet the requirements of Paragraph 2.1.4.4-Hardness.

TABLE IV

HARDNESS TEST SCALE

Primer Coat Fails to Rupture	Primer Coat Ruptures	Coleman-Smith Hardness Grade
H	2H	60
2H	3H	65
3H	4H	70
4H	5H	75
5H	6H	80
6H	7H	85
7H	8H	90
8H	9H	95
9H	--	100

Para. 2.4.14 Hardness: The hardness of the primer coat shall be at least 70 on the Coleman-Smith Scale of Table IV when tested in accordance with Paragraph 3.7.13.

Para. 3.7.12 Impact: Two type B panels (one baked*, one conditioned**) shall be tested in the following manner, using a guillotine-type impact tester. A weight sufficient to produce 85 inch pounds shall have a 1/2 inch diameter concave hemispherical punch attached to it. The test panel shall be placed on a 1/2 inch diameter concave hemispherical anvil cavity to match the punch. When the trigger of the impact tester is pulled, the falling weighted punch will cause a concave deformation of the primer coat. The test shall be repeated on the reverse side of the panel at a new position to form a convex deformation of the primer coat. The primer shall meet the requirements of:

Paragraph 2.4.13 - Impact

* Baked - The primed panel shall be air dried at room temperature for 24 hours, and then baked at 260°F for 100 hours prior to testing.

** Conditioned - The primed panel shall be air dried at room temperature for 24 hours, and then exposed to 50 percent plus or minus 10 percent humidity at room temperature for 7 days prior to testing).

B. Extract of Applicable Paragraphs of FMS-0004 (A), Enamel, Epoxy Base

Para. 3.7.7. - Fluid Resistance: Three conditioned Type B panels shall be immersed, one each in the 3 test fluids specified in paragraph 2.4.8. After 720 hours, the panels shall be removed from their respective test fluids, and shall meet the requirements of:

Paragraph 2.4.8 - Fluid Resistance.

The panels shall then be tested in accordance with:

Paragraph 3.7.12 - Impact
Paragraph 3.7.13 - Hardness

* Conditioned Type B panel is prepared from .032 inch thick unclad 7075-T6 Aluminum Alloy (Specification QQ-A-283), 6" x 3". The panel is given an anodic treatment conforming to Specification MIL-A-8625, Type I, and then sprayed with enamel to a coat thickness of 1.25 ± 0.25 mils. The coated panel is air dried at room temperature for 24 hours and then exposed to 50 percent plus or minus 10 percent humidity at room temperature for 7 days prior to testing.

Para. 2.4.8 Fluid Resistance: The enamel coat shall be capable of withstanding immersion in each of the following fluids for 720 hours at room temperature without wrinkling, roughening, blistering, checking or crazing.

Test Fluid MIL-H-3136 Type III
Hydraulic Fluid FMS-0006 (Same as MIL-H-8446B)
Lubricating Oil- MIL-L-7808

The enamel coat should not show a decrease in anchorage, hardness, nor impact resistance greater than that specified in Paras. 2.4.13 (Impact) 2.4.14(Hardness) and 2.4.15 (Anchorage).

(Note: This test used only two test fluids, Oronite 8515 and Royco 846, in lieu of test fluids noted.)

Para. 3.7.12 - Impact

Two Type B panels (one baked*, one conditioned)** shall be tested in the following manner, using a guillotine-type impact tester. A weight sufficient to produce 85 inch pounds shall have a 1/2 inch diameter convex hemispherical punch attached to it. The test panel shall be placed on a 1/2 inch diameter concave hemispherical anvil cavity to match the punch. When the trigger of the impact tester is pulled, the falling weighted punch will cause a concave deformation in the enamel coat. The test shall then be repeated on the reverse side of the panel at a new position to form a convex deformation of the enamel coat. The enamel shall meet the requirements of Paragraph 2.4.13 - Impact.

Para.3.7.12 - Cont'ed

*"Baked", the"Type B" test panel as described for Para 3.7.7 is baked for 100 hours at 260°F in lieu of exposure to 50 percent plus or minus 10% humdity at room temperature for 7 days.

** Conditioned - Refer to Para. 3.7.7 requirements.

Para. 2.4.13 - Impact:

The enamel coat,after baking, shall not show visible loss of adhesion under impact of 85 inch pounds when tested in accordance with Para. 3.7.12.

Para. 3.7.13 Hardness:

A conditioned Type B panel shall be used. Pencils ranging in hardness from H through 9H shall be prepared by cutting the wood at an angle of 45 degrees to the lead, leaving 0.11 ± 0.02 inch of lead exposed. The pencil lead shall then be squared by holding the lead vertically to a piece of fine sandpaper on a flat surface and grinding it with smooth, straight strokes, rotating the pencil 1/4 turn per stroke.

The pencil shall be held against the enamel coat at an angle of 45 degrees, then pushed firmly downward and forward attempting to rupture the coat with a force just short of breaking the pencil lead. Any rupture of the enamel coat shall be noted.

The test shall be repeated for each pencil hardness to determine the correlation with the Coleman-Smith hardness scale of Table VII.

The enamel coat shall meet the requirements of Paragraph 2.4.14 - Hardness.

TABLE VII
HARDNESS TEST SCALE

Enamel Coat Fails to Rupture	Enamel Coat Ruptures	Coleman-Smith Hardness-Grade
H	2H	60
2H	3H	65
3H	4H	70
4H	5H	75
5H	6H	80
6H	7H	85
7H	8H	90
8H	9H	95
9H	---	100

Para. 2.4.14 Hardness:

The hardness of the enamel coat shall be at least 70 on the Coleman-Smith hardness scale of Table VII when tested in accordance with Para. 3.7.13.

C. Extract of Applicable Paragraphs of FMS-0018(D). Packing: Hydraulic High Temperature, For Use in the B-58 Airplane

Volumetric Change (per FTMS 601, Method 6211)

Para. 3.6.2.4

Volumetric swell of the O-rings shall be measured on O-rings oil aged as specified in Paragraph 3.6.3.2 of this specification. (Specimen used was Q2825-325)

Para. 3.6.3.2: Oil Aging:

Install specimen in an air tight container in which dry air, test fluid, and specimen are positively sealed, so there is no air or test fluid leakage in or out. The air to fluid ratio shall be 10 parts of free air to one part of test fluid by volume. The fluid to specimen ratio shall be a minimum of 20 ml of fluid to 1 gram of specimens. Lay specimens flat in container on a .016 max. diameter stainless steel wire mesh with no more than 10 wires per inch. Wire shall be at least 0.25 inch above bottom of container.

With specimens immersed in test fluid, and air and fluid tightly sealed in container, assembly temperature shall be stabilized at 350°F. Maintain this condition for 72 hours. After exposure the assembly shall be placed in room temperature conditions, unsealed, and allowed to cool. A new batch of fluid shall be used for each aging test and only one material to be aged at a time.

Temperature of Retraction

Para. 3.6.6 Temperature of Retraction:

Determine TR-10 value in accordance with ASTM D1329-54T except use specimen in accordance with Table II, and initial elongation to be 50% and warm-up rate to be 1°F per minute. (Specimens used were Q-2825-218).

Tensile Strength (per FTMS 601, Method 4111)

Para. 3.6.2.2 - All pull type tests shall be made in a Scott test machine, or equivalent, equipped with driver (rotating) Scott ring spool tester attachment. Gage marks for determination of marks in the center of each spool. The distance between spool centers shall be set for zero elongation of the O-ring at the start of each test.

Cross section area to be used for tensile strength calculation in that the largest diameter allowed by Q2825 for the O-ring tested. (Specimen used was Q2825-325).

D. Extract of Applicable Paragraphs of FZC-4-035(A), "Wire, Insulated, Electrical, Aircraft (Modification of Specification MIL-W-5086)

Para. 3.5.3 Immersion (Reference Paragraph 4.4.5.4 of MIL-W-5086):

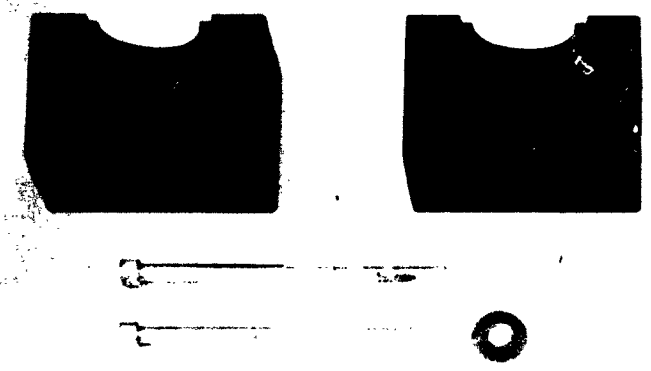
The specimen shall also be immersed in the following fluids.

(1) Hydraulic fluid, WADC Laboratory MLO 8200, at 350°F for 5 hours.

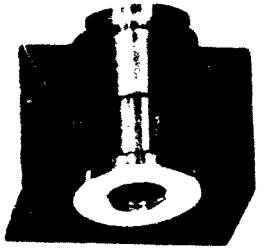
(2) Engine fuel, Grade JP-4, Specification MIL-F-5624.

Notes: Hydraulic fluids, Oronite 8515 and Royco 846, were substituted for (1) and (2) above, and the time and temperature was 5 hours at 350°F.

The dielectric strength of the wire will be determined after immersion per MIL-W-5086, Paragraph 4.4.5.1.3.



CYLINDER LAY UP JIG



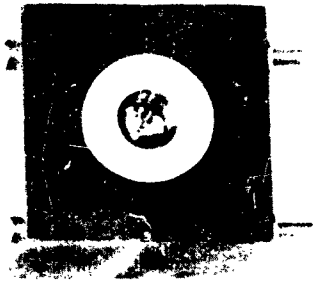
CYLINDER POSITION

IN LAY UP JIG

(CROSS SECTION VIEW)

CONVAIR

TEST CYLINDERS

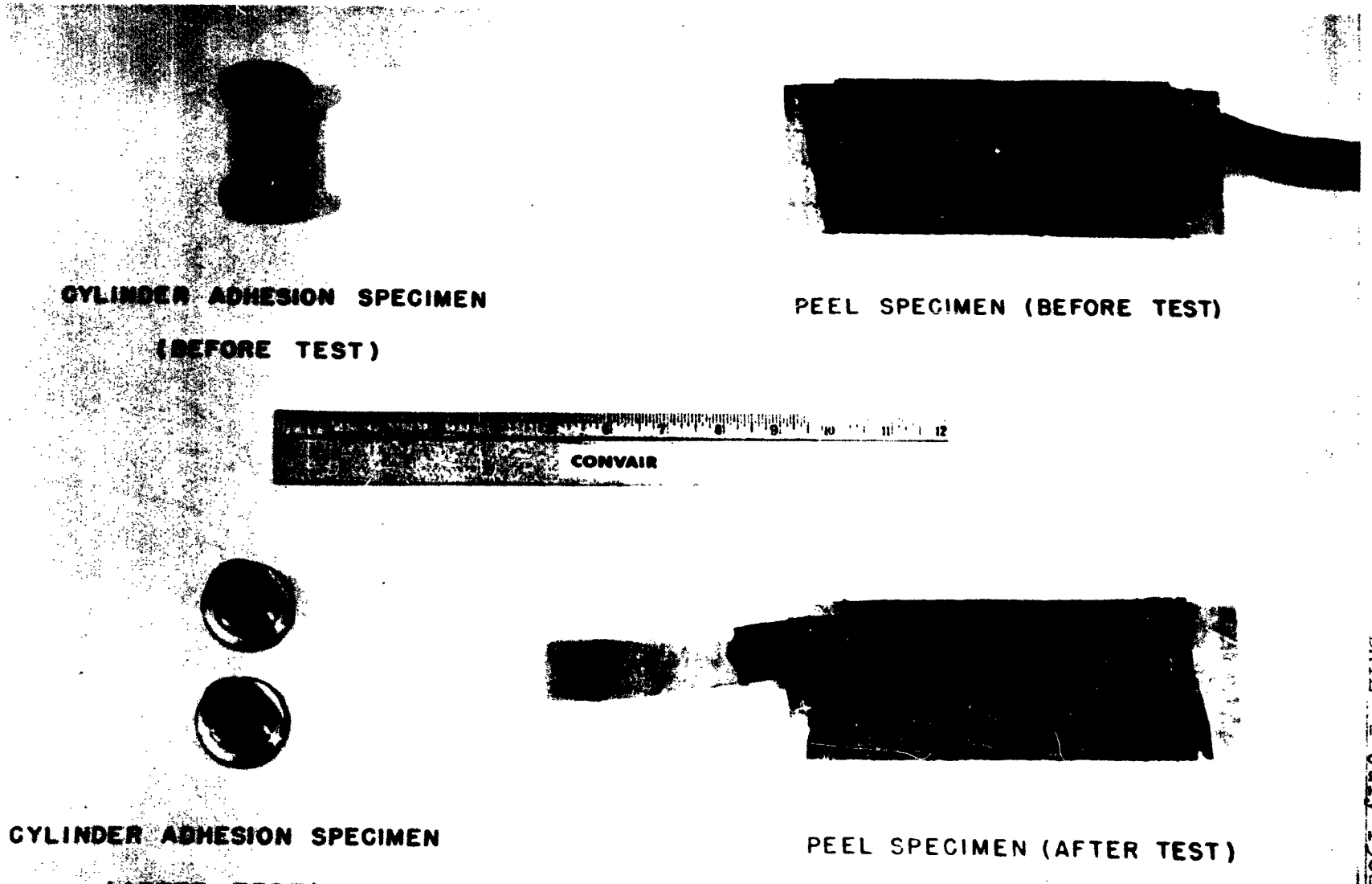


CYLINDER POSITION

IN LAY UP JIG

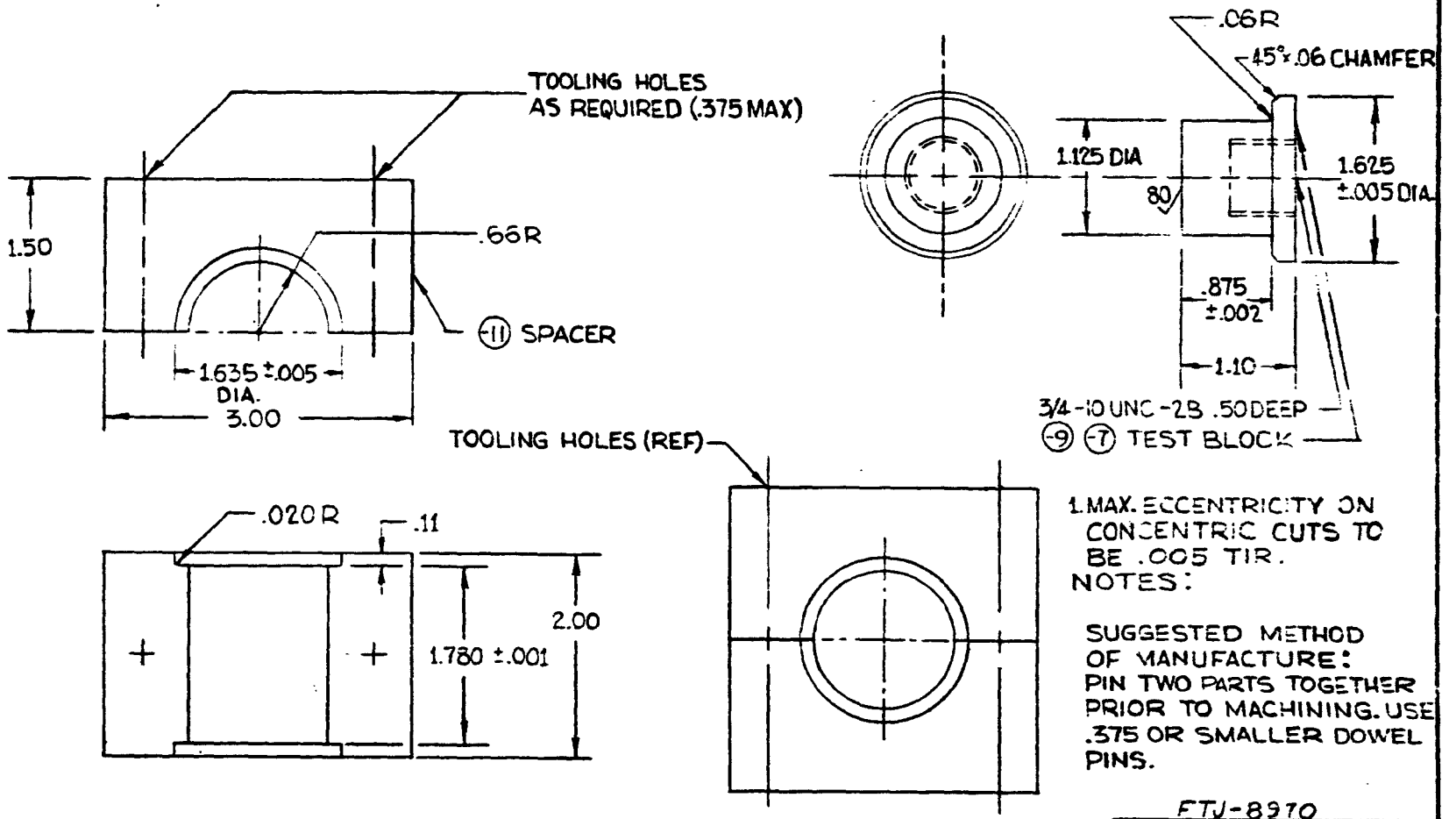
(TOP VIEW)

LAYUP OF CYLINDER ADHESION TEST SPECIMENS
B-58, GENERAL DYNAMICS, FORT WORTH



CYLINDER ADHESION AND PEEL TEST SPECIMENS
B-58, GENERAL DYNAMICS, FORT WORTH

Figure 1



1. MAX. ECCENTRICITY ON CONCENTRIC CUTS TO BE .005 TIR.

NOTES:

SUGGESTED METHOD OF MANUFACTURE: PIN TWO PARTS TOGETHER PRIOR TO MACHINING. USE .375 OR SMALLER DOWEL PINS.

DASH NO.	DESCRIPTION	STOCK SIZE	MATERIAL	MATL SPECIFICATION
-11	SPACER	2.25 x 3 x 1.6	SAE 1018	COMMERCIAL GRADE
-9	TEST BLOCK	1 3/4 DIA. x 1.3	7075 - T6	QQA-282-T6
-7	TEST BLOCK	1 3/4 DIA. x 1.3	18-8 CRES	MIL-S-7720

FTJ-8970

TEST BLOCK
SEALANT ADHESION
TEST

SCALE: FULL